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Production of the H dibaryon via the (K^{-}, K^{+}) reaction on a ^{12}C target

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Abstract

We study the production of the stable six-quark H dibaryon via the (K^{-}, K^{+}) reaction on a ^{12}C target within a covariant effective Lagrangian model. We follow a factorization approximation, in which the full production amplitude is written as a product of the amplitudes for the $K^{-} + p \to K^{+} + \Xi^{-}$ and $\Xi^{-} + p \to H$ processes. The $K^{+}\Xi^{-}$ production vertex is described by excitation, propagation and decay of Λ and Σ resonance states in the initial collision of a K^{-} meson with a target proton in the incident channel. The parameters of the resonance vertices are taken to be the same as those determined previously by describing the available data on total and differential cross sections for the $p(K^{-}, K^{+})\Xi^{-}$ reaction within a similar model. The $\Xi^{-} + p \to H$ fusion process is treated within a quark model where the H dibaryon is considered as a stable particle. For the K^{+} meson angle fixed at 0°, the H production cross-section is found to be about 2.7 $\mu b/sr$ for H mass just below the $\Lambda\Lambda$ threshold at a K^{-} beam momentum of 1.67 GeV/c. This is an order of magnitude larger than the value for this quantity reported earlier in calculations performed on a ^{3}He target using a different model for the cascade hyperon production. We have also calculated the beam momentum dependence of the H production cross section and the energy spectrum of the emitted K^{+} meson.

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Within the quark-bag model, the H dibaryon, a six-quark [two up (u), two down (d) and two strange (s)] state with spin-parity $J^\pi = 0^+$, and isospin $I = 0$, was predicted to be a stable system with a mass about 80 MeV below the $\Lambda\Lambda$ threshold, some 35 years ago [1]. Later calculations that included the center-of-mass (CM) [2] and pionic-cloud [3] corrections within this model, predicted this state to be much less bound or even unbound. Since then a lot of experimental effort has gone into searching for the H dibaryon (see, *e.g.*, the review [4] for references up to the year 2000 and Refs. [5] and [6] for more recent investigations done by Japan's National Laboratory for High Energy Physics (KEK) and STAR at RHIC collaborations, respectively). These studies have led to the conclusion that the existence of this system as a deeply bound object is highly unlikely. At the same time, the observation of the double-Λ hypernuclues ${}^{6}_{\Lambda\Lambda}$He (NAGARA event) and the precise determination of its binding energy at KEK in the experiment E373 [7] has put a lower limit of 2.2237 GeV to the H-dibaryon mass at a 90% confidence level, which is just about 7.7 MeV below the $\Lambda\Lambda$ threshold.

The interest in the H-dibaryon has been revived by the recent lattice quantum chromodynamics (LQCD) calculations of different groups. The NPLQCD [8] and HAL QCD [9] collaborations have reported that the H particle is indeed bound at somewhat larger than physical pion masses. However, extrapolations of the calculations of these groups to the physical pion mass region suggest [10, 11] that this particle is likely to be either very loosely bound or an unbound state near the $\Lambda\Lambda$ threshold. In a very recent chiral constituent quark model calculation [12], the value extracted for the binding energy of the H particle has been found to be compatible with the restrictions imposed by the NAGARA event. These results together with the previous experiments [5] that give a hint on the existence of a possible H-dibaryon resonance, have led to a proposal to look for this particle in a future experiment [13] at the Japan Proton Accelerator Research Complex (JPARC) using a high intensity K^- beam. This is expected to answer the long standing question about the existence of the H-dibaryon. Furthermore, with the measurement of the exclusive Ξ^- production in the $\gamma p \to K^+K^+\Xi^-$ reaction at the Jefferson Laboratory [14], a possibility has been opened for producing the H-dibaryon with the photon beam.

The (K^-, K^+) reaction leads to the transfer of two units of both charge and strangeness to the target nucleus. Thus this reaction is one of the most promising ways of studying the production of $S = -2$ systems such as Ξ hypernuclei and the H-dibaryon. Recently, the production of cascade hypernuclei via the (K^-, K^+) reaction on nuclear targets, has been investigated within an effective Lagrangian model [15]. This is a new approach, where the $K^+\Xi^-$ production vertex is described by

excitation, propagation and decay of Λ and Σ resonance intermediate states in the initial collision of the K^- meson with a target proton in the incident channel. The Ξ^- hyperon gets captured into one of the nuclear orbits leading to the formation of the Ξ^- hypernucleus. The parameters at the resonance vertices were determined by describing the available data on total and differential cross sections for the elementary process $p(K^-, K^+)\Xi^-$ within a similar approach [16], where contributions were included from the s-channel and u-channel diagrams, which have as intermediate states Λ and Σ hyperons together with eight of their three-and four-star resonances [$\Lambda(1405)$, $\Lambda(1520)$, $\Lambda(1670)$, $\Lambda(1810)$, $\Lambda(1890)$, $\Sigma(1385)$, $\Sigma(1670)$ and $\Sigma(1750)$] with masses up to 2 GeV. It was observed in this study that the total cross section of the $p(K^-, K^+)\Xi^-$ reaction is dominated by the contributions from the $\Lambda(1520)$ (with $L_{IJ} = D_{03}$) resonance intermediate state. The region for beam momentum (p_{K^-}) below 2.0 GeV/c was shown to be dominated by contributions from the s-channel graphs - the u-channel terms are dominant only in the region p_{K^-} ¿ 2.5 GeV.

In calculations of the Ξ^- hypernuclear production cross sections, one requires additionally the bound state spinors for the proton hole and Ξ^- particle bound states. These were obtained by solving the Dirac equation with vector and scalar potential fields having Wood-Saxon shapes. Their depths were fitted to the binding energies of the respective states. In Ref. [15] bound state spinors obtained in the quark-meson coupling (QMC) model [17] were also used. The cross sections for the hypernuclear production were found to be quite different from those calculated previously in Ref. [18].

In this paper, we describe the production of the H-dibaryon by the (K^-, K^+) reaction on a ^{12}C target using a similar approach. The basic production mechanism considered in our work is depicted in Fig. 1, where the reaction proceeds in two steps. In the first step the $K^+\Xi^-$ production takes place by following the process as described above while in the second step the Ξ^- hyperon fuses with another proton of the residual nucleus to form the H dibaryon. A similar method was also used earlier in Refs. [19–21] in calculations of the production of this particle via (K^-, K^+). However, there are two important differences between those calculations and the present work. (i) We use the proper three-body phase space and kinematics for the $K^- + {}^{12}\mathrm{C} \rightarrow K^+ + H + {}^{10}\mathrm{Be}$ process. (ii) We calculate the $K^+\Xi^-$ production amplitude by employing the method described in the previous paragraph that was applied in our calculations of the Ξ^- hypernuclei [15], while these authors used a parameterization of the sparsely available experimental zero degree differential cross-section for the $p(K^-, K^+)\Xi^-$ reaction and multiplied them by the target wave function. The earlier calculations were limited to a very light ^{3}He target nucleus, whereas we apply our method

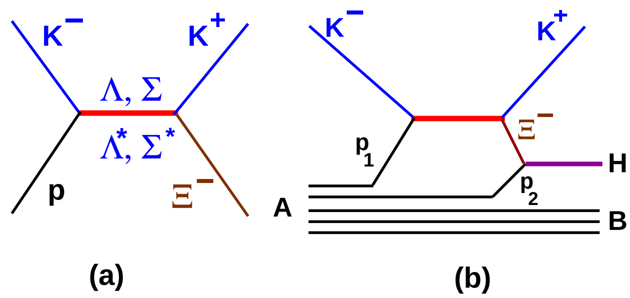

FIG. 1. (color online) Graphical representation of the model used to describe the $p(K^-, K^+)\Xi^-$ (Fig. 1a) and $A(K^-, K^+)HB$ reactions (Fig. 1b), where A represents the target nucleus while B = (A-2) the residual nucleus. In Fig. 1a, Λ^* and Σ^* represent the Λ and Σ resonance states, respectively.

to ^{12}C. This makes it possible to compare our cross sections directly to the existing experimental results and to make predictions for future measurements.

It should be remarked that there may be other processes also through which the *H*-dibaryon production can proceed. These are termed higher order processes in Ref. [20], where it was shown that their contributions are not expected to be large. Like these authors, we have neglected such diagrams in our study.

The general formula for the invariant cross section of the $K^- + A \rightarrow K^+ + H + B$ reaction is written as(see,*e.g.*, Ref. [22]),

$$d\sigma = \frac{m_H m_A m_B}{\sqrt{[(p_{K^-} p_A)^2 - m_{K^-}^2 - m_A^2]}} \frac{1}{4(2\pi)^5} \delta^4(P_f - P_i)|A_{fi}|^2 \frac{d^3 p_{K^+}}{E_{K^+}} \frac{d^3 p_B}{E_B} \frac{d^3 p_H}{E_H}, \tag{1}$$

where A_{fi} represents the total amplitude, P_i and P_f the sum of all the momenta in the initial and final states, respectively, and m_H, m_A and m_B the masses of *H*-dibaryon, and nuclei A and B, respectively. The cross sections in the laboratory or CM systems can be written from this equation by imposing the relevant conditions. It may be noted that summations over final spin states and average over initial spin spates are implied in A_{fi}.

Following the factorization approximation of Ref. [20], the total amplitude A_{fi} is written as the product of the amplitudes for the processes $K^- + p_1 \rightarrow K^+ + \Xi^-$ ($M_{p_{K^-}, p_1, p_{\Xi^-}}$), and $\Xi^- + p_2 \rightarrow H$ (F_{p_2}, p_{Ξ^-}) (see Fig. 1b). We write

$$\begin{aligned} A_{fi} = & \int \frac{d^4 p_1}{(2\pi)^4} \int \frac{d^4 p_2}{(2\pi)^4} \delta(p_1 + p_{K^-} - p_{Y^*}) \delta(p_{Y^*} - p_{K^+} - p_{\Xi^-}) \delta(p_H - p_{\Xi^-} - p_2) \\ & \times \Big[\sum_{Y^*} M_{p_{K^-}, p_1, p_{\Xi^-}}(K^- + p_1 \rightarrow K^+ + \Xi^-) \Big] F_{p_2}, p_{\Xi^-}(\Xi^- + p_2 \rightarrow H), \end{aligned} \tag{2}$$

where p_{K^-}, p_{K^+}, p_{Y^*}, and p_{Ξ^-} are the four momenta of the incoming and outgoing kaons, intermediate resonance state and the Ξ^- hyperon, respectively. The amplitude $M_{p_{K^-},p_1,p_{\Xi^-}}$, where the summation is done over all the resonance intermediate states Y^* as described above, has been determined by following the method discussed in Ref. [15]. The effective Lagrangians, the corresponding coupling constants and the form factors for the resonance-kaon-baryon vertices, the propagators for the intermediate resonances and the bound state and free-space wave functions for the bound proton p_1 and the intermediate Ξ^- hyperon, respectively, as used in the calculations if the amplitude M, are discussed in the following.

The effective Lagrangians for the resonance-kaon-baryon vertices for spin-$\frac{1}{2}$ and spin-$\frac{3}{2}$ resonances are taken as

$$\mathcal{L}_{KBR_{1/2}} = -g_{KBR_{1/2}}\bar{\psi}_{R_{1/2}}[\chi\, i\Gamma\,\varphi_K + \frac{(1-\chi)}{M}\,\Gamma\,\gamma_\mu\,(\partial^\mu\varphi_K)]\psi_B, \tag{3}$$

$$\mathcal{L}_{KBR_{3/2}} = \frac{g_{KBR_{3/2}}}{m_K}\bar{\psi}^\mu_{R_{3/2}}\partial_\mu\phi_K\psi_B + \text{h. c.}, \tag{4}$$

with $M = (m_R \pm m_B)$, where the upper sign corresponds to an even-parity and the lower sign to an odd-parity resonance with B representing either a nucleon or a Ξ hyperon. The operator Γ is γ_5 (1) for an even- (odd-) parity resonance. The parameter χ controls the admixture of pseudoscalar and pseudovector components. The value of this parameter is taken to be 0.5 for the Λ^* and Σ^* states, but zero for Λ and Σ states, implying pure pseudovector couplings for the corresponding vertices, in agreement with Refs. [22, 23]. It may be noted that the Lagrangian for spin-$\frac{3}{2}$, as given by Eq. (4), corresponds to that of a pure Rarita-Swinger form which has been used in all previous calculations of the hypernuclear production reactions within a similar effective Lagrangian model [23–25]. The values of the vertex parameters were taken to be the same as those given in Ref. [15].

Similar to Refs. [15, 16], we have used the following form factor at various vertices,

$$F_m(s) = \frac{\lambda^4}{\lambda^4 + (s - m^2)^2}, \tag{5}$$

where m is the mass of the propagating particle and λ the cutoff parameter, which is taken to be 1.2 GeV, which is the same as that used in Refs. [15, 16].

The two interaction vertices of Fig. 1 are connected by a resonance propagator. For the spin-1/2 and spin-3/2 resonances, the propagators are given by

$$\mathcal{D}_{R_{1/2}} = \frac{\mathrm{i}(\gamma_\mu p^\mu + m_{R_{1/2}})}{p^2 - (m_{R_{1/2}} - \mathrm{i}\Gamma_{R_{1/2}}/2)^2}, \tag{6}$$

and

$$\mathcal{D}^{\mu\nu}_{R_{3/2}} = -\frac{\mathrm{i}(\gamma_\lambda p^\lambda + m_{R_{3/2}})}{p^2 - (m_{R_{3/2}} - \mathrm{i}\Gamma_{R_{3/2}}/2)^2} P^{\mu\nu} \ , \tag{7}$$

respectively. In Eq. (7) we have defined

$$P^{\mu\nu} = g^{\mu\nu} - \frac{1}{3}\gamma^\mu\gamma^\nu - \frac{2}{3m^2_{R_{3/2}}} p^\mu p^\nu + \frac{1}{3m_{R_{3/2}}} (p^\mu\gamma^\nu - p^\nu\gamma^\mu) \ . \tag{8}$$

In Eqs. (6) and (7), $\Gamma_{R_{1/2}}$ and $\Gamma_{R_{3/2}}$ define the total widths of the corresponding resonances. We have ignored any medium modification of the resonance widths while calculating the amplitude M, as information about them is scarce and uncertain.

The bound proton wave function $[\psi(p_1)]$ is a four component Dirac spinor that is the solution of the Dirac Equation for a bound state problem in the presence of external scalar and vector potential fields. This is written as

$$\psi(p_1) = \delta(p_{10} - E_1) \begin{pmatrix} f(k_1)\mathcal{Y}^{m_j}_{\ell 1/2 j}(\hat{p}_1) \\ -ig(k_1)\mathcal{Y}^{m_j}_{\ell' 1/2 j}(\hat{p}_1) \end{pmatrix}, \tag{9}$$

where $f(k_1)$ and $g(k_1)$ are the radial parts of the upper and lower components of the spinor $\psi(p_1)$. In this equation, $\mathcal{Y}^{m_j}_{\ell 1/2 j}$ are the coupled spherical harmonics

$$\mathcal{Y}^{m_j}_{\ell 1/2 j} = < \ell m_\ell 1/2 \mu_i | j m_j > Y_{\ell m_\ell}(\hat{p}_1)\chi_\mu, \tag{10}$$

and $\ell' = 2\ell - j$ with ℓ and j being the orbital and total angular momenta, respectively. Y represents the spherical harmonics, and χ_μ the spin space wave function of a spin-$\frac{1}{2}$ particle.

We assume that the nucleon bound state has a pure single-hole configuration with the core remaining inert. The spinors in momentum space are obtained by Fourier transformation of the corresponding coordinate space spinors, which are the solutions of the Dirac equation with potential fields consisting of an attractive scalar part (V_s) and a repulsive vector part (V_v) having a Woods-Saxon form. For fixed geometry parameters (radius and diffuseness) we search for the depths of these potentials to reproduce the binding energy of the respective state. For the p_1 proton (see Fig. 1b) this state has the quantum numbers $1p_{3/2}$ with a binding energy of 15.96 MeV. The searched depths were 382.6 MeV and -472.3 MeV, respectively for the fields V_v and V_s with the radius and diffuseness parameters of 0.983 fm and 0.606 fm, respectively for both. It should be added here that these spinors were the same as those used in Refs. [25] the production of the Λ hypernuclei via the (γ, K^+) reaction on a ^{12}C target.

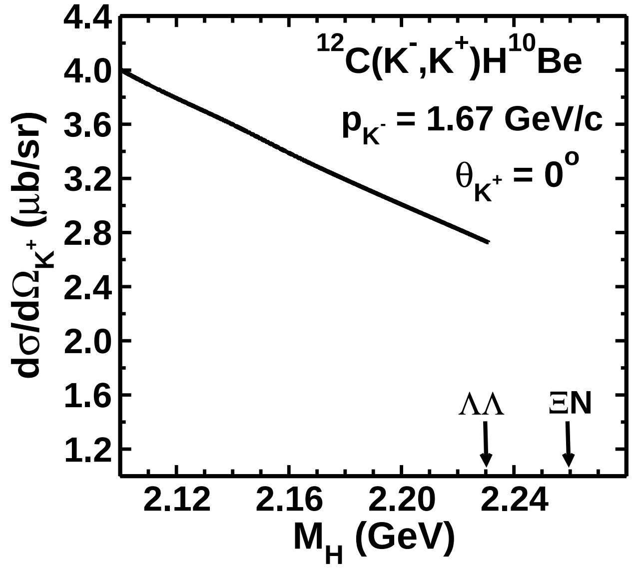

FIG. 2. (color online) Differential cross section $d\sigma/d\Omega_{K^+}$ at $\theta_{K^+} = 0^\circ$ for H production in the $^{12}\mathrm{C}(K^-, K^+)H^{10}\mathrm{Be}$ reaction at the beam momentum of 1.67 GeV/c, as a function for H-dibaryon mass. The $\Lambda\Lambda$ and ΣN thresholds are shown by inverted arrows as indicated.

The free-space spinors for the Ξ^- hyperon are written as

$$\Psi(p_{\Xi^-}) = \delta(p_{\Xi^-_0} - E_{\Xi^-}) \sqrt{\frac{E_{\Xi^-} + m_{\Xi^-}}{2m_{\Xi^-}}} \begin{pmatrix} \chi_\mu \\ \frac{\sigma \cdot \boldsymbol{p}_{\Xi^-}}{E_{\Xi^-} + m_{\Xi^-}} \chi_\mu \end{pmatrix} \tag{11}$$

After having established the vertices and the corresponding coupling constants as well as the forms of the propagators, the amplitudes M can be written by following the well known Feynman rules and can be numerically evaluated using the bound state and the free-space spinors. We have used a plane wave approximation to describe the relative motions of the kaons in the incoming and outgoing channels. However, the distortion effects are partially accounted for by introducing reduction factors to the cross sections as described in Ref. [15]. It may be noted that these factors correspond to absorption effects on only the K^- and K^+ wave functions. There could still be the distortion effect on the $H - B$ relative motion in the final channel which is ignored here. Since all of our calculations are carried out in momentum space, they include all the nonlocalities in the production amplitudes that arise from the resonance propagators.

For calculating the amplitude $F_{p_2, p_{\Xi^-}}$, we follow the same procedure as described in Ref. [20]. In this method, the H-dibaryon is treated as a bound particle with a mass m_H, however its six quark structure is taken into account. This implies that three-quark internal structure of the Ξ^- hyperon and the proton p_2 (see Fig. 1b) also have to be invoked as the formation of H is thought of in terms

of the fusion of two three-quark bags (Ξ^- and p_2). The proton p_2 is supposed to be picked up from the same orbit as p_1 and has a binding energy of 11.22 MeV. The amplitude F is calculated by taking the overlap of the internal wave functions of H, Ξ^- and p_2, which are described by a Gaussian approximation (see, Ref. [19]). The final result for the amplitude F is given by

$$F_{p_{p_2},p_{\Xi^-}}(\Xi^- + p_2 \to H) = \Gamma_0\Big(\frac{2R_pR_H}{R_H^2 + R_p^2}\Big)^3\Big(\frac{2R_{\Xi^-}R_H}{R_H^2 + R_{\Xi^-}^2}\Big)^3\Big(\frac{R_H^2}{3\pi}\Big)^{3/4} \times exp\Big[-\frac{R_H^2}{12}(\boldsymbol{p}_2 - \boldsymbol{p}_{\Xi^-})^2\Big], \quad (12)$$

where the factor Γ_0 arises from the color-flavor-spin recoupling as defined in Ref. [20]. Its value is $\sqrt{1/20}$. The values of the oscillator parameters, R_p, R_{Ξ^-} and R_H have been taken to be 0.83 fm, 0.73 fm and 0.95 fm, respectively. The chosen value of R_p reproduces the root mean square (rms) radius of the proton, while the value of R_{Ξ^-} comes from the quark-bag model relation between the proton bag radius and that of the Ξ^-. The bag radius of the H-dibaryon is about 20% larger than that of the proton (see, eg. Refs. [2, 3]). Therefore, we have increased the value of R_H over R_p accordingly. We do not use the approximation $R_p = R_{\Xi^-} = R_H$ as done in Refs. [20, 21]. It should be remarked here that in deriving Eq. 12, the normalizations of the baryon wave functions are made consistent with those used for them in the amplitude M.

The method discussed above has been used to calculate the cross-sections for the ^{12}C$(K^-, K^+)H^{10}$Be reaction. In Fig. 2, we show the results for the differential cross section $d\sigma/d\Omega_{K^+}$ at the K^+ angle of 0° and the beam momentum (p_{K^-}) of 1.67 GeV/c as a function of the rest mass of H-dibaryon. We see that the cross sections decrease uniformly as m_H approaches the $\Lambda\Lambda$ threshold (indicated by an arrow) where we stopped the calculations because our method treats H as a bound particle. It should be noted that near this threshold our cross section is about an order of magnitude larger than that reported in Ref. [20] at the beam momentum of 1.8 GeV/c on a ^{3}He target. In Ref. [5], the production cross section of H with a mass range between $\Lambda\Lambda$ and ΣN thresholds (also indicated in Fig. 2 by an arrow) has been found to be 2.1 ± 0.6 (stat.) ± 0.1 (syst.) $\mu b/sr$ at a 90% confidence level, in a measurement of the ^{12}C$(K^-, K^+)\Lambda\Lambda X$ reaction at the beam momentum of 1.67 GeV/c where K^+ meson was confined mostly in the forward directions. We see in Fig. 2 that our cross-section at the $\Lambda\Lambda$ threshold is comparable to this value.

In Fig. 3, we show the beam momentum dependence of the $d\sigma/d\Omega_{K^+}$ of the same reaction as that of Fig. 2. We note that the cross section peaks near the p_{K^-} value of about 1.3 GeV/c, which is approximately 0.50 GeV/c away from the production threshold for this reaction. This is similar to

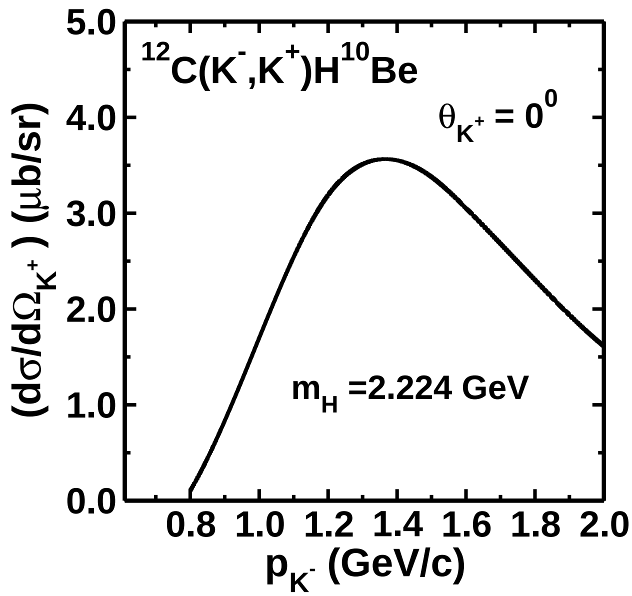

FIG. 3. (color online) Differential cross section $d\sigma/d\Omega_{K^+}$ at $\theta_{K^+} = 0°$ for the same reactions as in Fig. 2 reaction as a function of the beam momentum p_{K^-} corresponding to a M_H of 2.224 GeV.

the situation in the case of the zero degree differential cross section of the elementary production reaction $p(K^-, K^+)\Xi^-$, where the peak occurs near a value of p_{K^-}, which is away by a similar amount from the corresponding production threshold (see Fig. 4 of Ref. [15]). On the other hand, the distribution in Fig. 3 is broader as compared to that of the elementary reaction. This can be attributed to the three-body phase-space factor (see the discussions below) and also partly to the Fermi motion of the protons in the target nucleus.

If one compares the magnitude of the peak cross section in Fig. 3 with that of the elementary production reaction, one notices that the H production cross section is smaller than that of the $p(K^-, K^+)\Xi^-$ reaction by at least an order of magnitude. This reflects the fact that H production occurs only in a limited region of $\Xi^- - p$ relative momenta. This figure further shows that in contrast to conclusions of Refs. [20] and [21], using a K^- beam of lower momentum, around 1.4 GeV/c, provides the maximum probability of producing H-dibaryon via the (K^-, K^+) reaction on a ^{12}C target. It is expected that use of a heavier target like *Cu* (which is supposed to be employed in the experiment to be conducted in the proposal of Ref. [13]) will push the peak in the cross section to even lower beam momenta because the corresponding production threshold would be lower than that on a ^{12}C target (the threshold beam momentum for the ^{63}Cu target is 0.701 GeV as compared to 0.735 GeV for the ^{12}C corresponding to a M_H of 2.224 GeV).

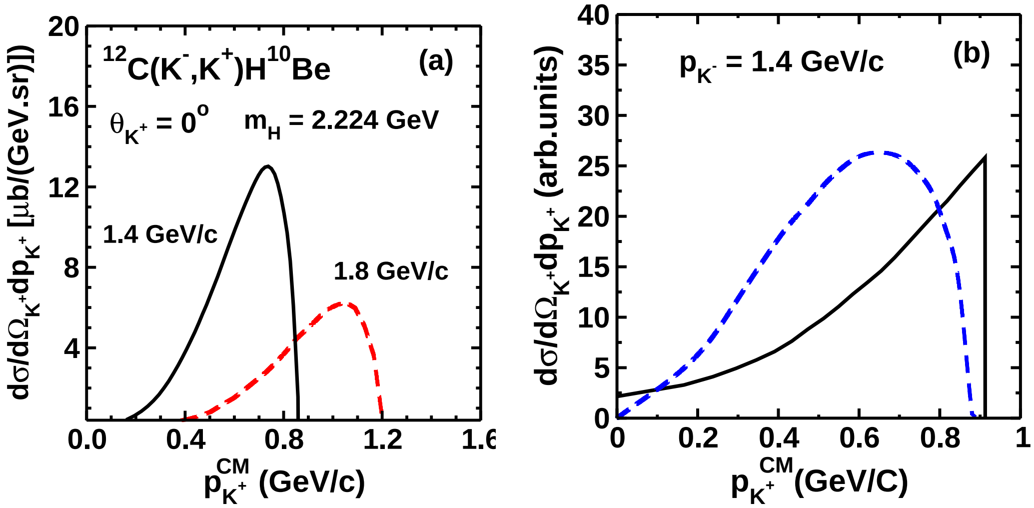

FIG. 4. (color online) (a) Double differential cross section $d\sigma/d\Omega_{K^+}dp_{K^+}$ at $\theta_{K^+} = 0°$ for the ^{12}C$(K^-, K^+)H^{10}$Be reaction as a function of the center-of-mass momentum p_{K^+} of the K^+ meson at the p_{K^-} values of 1.4 GeV/c and 1.8 GeV/c. (b) Relative contributions of phase-space (dashed line) and the production amplitude (solid line) parts to the cross section of the same reactions as in (a) at p_{K^-} =1.4 GeV/c for the same K^+ angle and the H mass. The curves are normalized to the same maxima.

In Fig. 4(a), we show the double differential cross section $d\sigma/d\Omega_{K^+}dp_{K^+}$ for the same reaction as in Fig. 3 at the beam momenta of 1.4 GeV/c and 1.8 GeV/c, corresponding to the CM angle $\theta_{K^+} = 0°$, as a function of the CM momentum of K^+ ($p_{K^+}^{CM}$). The H-dibaryon mass was taken to be 2.224 GeV which is in the region where it is more likely to be located. It is seen that the cross sections are peaked very close to the kinematically allowed maximum $p_{K^+}^{CM}$ regardless of the beam momentum. Since we have used the correct three-body phase-space factor, our K^+ spectra are broader than those given in Refs. [20] and [21]. This is evident from Fig. 4(b) where we show the contributions of the phase-space only and the production amplitude only components to the K^+ spectrum at the beam momentum of 1.4 GeV/c and for the same value of m_H as in Fig. 4(a). The curves are normalized to the same maxima so that their respective widths can be easily compared. We see that while the production amplitude part has a relatively narrower width and it peaks right at the maximum possible $p_{K^+}^{CM}$, the three-body phase-space part is broad and has a maximum at somewhat lower $p_{K^+}^{CM}$. This results in a broader K^+ spectrum with a peak at somewhat below the maximum value of the K^+ CM momentum. It is likely that the use of the approximate phase-space factor of Refs. [20, 21] is the reason for the narrower widths of the K^+ spectrum obtained by those authors.

In summary, we have studied the production of the stable six-quark H-dibaryon, which has spin-parity 0^+, isospin 0 and strangeness -2 via the (K^-, K^+) reaction on a ^{12}C target within an effective Lagrangian model. The model assumes this reaction to proceed in two steps. In the first step, Ξ^- hyperon and a K^+ meson are produced in the initial collision of the K^- meson with a target proton. In the second step, the Ξ^- hyperon fuses with another target proton to produce the H-dibaryon. Although, similar models have been used earlier for such investigations, we have made several improvements to them. We employ a proper three-body phase-space to describe the A$(K^-, K^+)HB$ reaction. The $\Xi^- + K^+$ production amplitude has been calculated by excitation, propagation and decay of Λ and Σ hyperon resonance intermediate states in the initial collision of the K^- meson with a target proton. The vertex parameters (the coupling constants, and the form factors) at the resonance vertices have been taken to be the same as those fixed earlier by describing both the total and the differential cross sections of the elementary $p(K^+, K^-)\Xi^-$ reaction within a similar model. The same parameters were also used previously in the calculations of the Ξ hypernuclei. The bound proton spinors have been obtained by solving the Dirac equation with vector and scalar potential fields having Woods-Saxon shapes. Their depths are fitted to the binding energy of the respective state. This is in contrast to the previous studies where $\Xi^- + K^+$ amplitudes were obtained by parameterization of the not so well known experimental differential cross sections of the $p(K^+, K^-)\Xi^-$ reaction at 0°. Unlike the previous studies where the numerical calculations were limited to a light ^{3}He target, we have applied our model to compute cross sections for a ^{12}C target. This makes it possible to make comparison, *albeit* indirectly, with the currently available limited data and to make predictions for future measurements.

We find that the H dibaryon production cross sections in the $^{12}\text{C}(K^-, K^+)H\,^{10}\text{Be}$ reaction are more than an order of magnitude larger than those calculated earlier on a ^{3}He target. The magnitude of this cross-section for a H mass very close to the $\Lambda\Lambda$ threshold, is comparable to the H production cross section determined in a study of the $^{12}\text{C}(K^-, K^+)\Lambda\Lambda X$ reaction just above this threshold with a 90% confidence level. We notice that the differential cross-section for the $^{12}\text{C}(K^-, K^+)H\,^{10}\text{Be}$ reaction for observing K^+ at zero degrees peaks around the beam momentum of 1.4 GeV/c, which is above the production threshold of this reaction by almost the same amount as the position of the maximum is in the zero degree differential cross section in the elementary $p(K^-, K^+)\Xi^-$ reaction above the corresponding threshold.

The spectrum of the K^+ meson has a peak very close to the kinematically allowed maximum K^+ momenta and its width is broader than that observed in previous studies of this reaction on

a ^{3}He target. This is the consequence of using correct three-body phase-space and kinematics. The broad width of this spectrum might ease the experimental constraints on their measurements, with a caveat that it might become comparable with those of some background processes like the momentum spectrum of K^+ recoiling against the continuum $\Xi^- p$ pair [20, 21]. However, the relatively large magnitude and shifted peak position of the cross sections for the latter process should make it possible to separate them from the H production events.

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